

Cummins Inc. Consent Decree
Environmental Offset Programs
September 2000

Cummins Inc. Consent Decree Offset Projects

Table Of Contents

EPA Approved Projects	Page
• On-highway Low NOx Incentive (50 State Program).....	3
• New York Sanitation Truck PM Retrofit.....	3
• Washington D.C. Mass Transit PM Retrofit.....	4
• Metropolitan Atlanta Rapid Transit Authority CNG Buses.....	5
• Massachusetts Bay Transit Authority CNG Buses.....	6
• Northeast States Hybrid Bus Consortium.....	6
• Exhaust Aftertreatment Research and Demonstration.....	7
• Alternative Fuel Technology and Engine Program.....	8
• Chassis Dynamometer Vehicle Test.....	8
 ARB Approved Projects	
• On-highway Low NOx Incentive (50 State Program).....	9
• Los Angeles School Bus Repower and PM Treatment.....	9
• San Juan and Elk Grove Bus Repower and PM Treatment.....	9
• High Pressure Direct Injection (HPDI) LNG On-highway.....	10
• High Pressure Direct Injection (HPDI) Ultra Low Emissions Technology.....	11
• High Pressure Direct Injection (HPDI) – Phase II: Field Testing.....	11
• ISL_G Natural Gas Engine Integration.....	12

- Advanced Emissions Measurement Support.....12

Cummins Inc. Consent Decree Offset Projects

EPA Approved Projects

On-highway Low NOx Incentives (50 State Program)

Planned Spending: \$6.7 million (\$ 1.7 ARB, \$ 5.0 EPA)

Project Description:

Cummins proposes to develop an incentive program to recalibrate engines, long before rebuild, to a lower emissions level. The program would be directed toward the owner-operator segment of the heavy-duty truck market utilizing engines built in 1996 and later. By targeting the most recently built engines, Cummins will maximize the emissions reduction potential (newer engines have fewer miles, and thus have the longest expected life before overhaul). The calibrations used for the program would use existing "Low NOx" calibrations currently submitted for the rebuild program.

Cummins intends to conduct reviews of this program annually to assure the programs effectiveness. Adjustments will be implemented as required.

Environmental Benefit:

It is estimated that the early recalibrations may result in 30,000 tons of NOx reductions.

New York Sanitation Truck PM Retrofit

Planned spending: \$1.95 million

Project Description:

Cummins intends to retrofit approximately 260 Cummins engine heavy-duty sanitation vehicles with emission control devices (ECD) within the five boroughs of NY City. This project will include approximately 260 trucks with advanced ECDs including but not limited to diesel particulate filters (DPF), potentially from a variety of manufacturers. The program also intends to put into service four compressed natural gas (CNG) street sweepers. At predetermined intervals of operation, a representative cross-section of ECDs will be removed and evaluated in an emission test cell. A small portion of the retrofitted fleet will also be evaluated on a chassis dynamometer. Exhaust parameters (e.g. backpressure) will be monitored as an indicator of aftertreatment plugging and/or failure. If successful during the two-year tracking period, these units will remain in service after conclusion of the project.

Project Goals:

1. Reduce PM and HC emissions from in-use heavy-duty diesel engines in local urban, ozone and PM non-attainment area neighborhoods;
2. Facilitate the successful retrofit of sanitation type vehicles, as well as their long-term maintenance;
3. Assess the effectiveness of DPF technologies in reducing pollution over long periods of time; and
4. Quantify the emissions reductions achieved from the retrofit program and from each emission control device;

Environmental Benefit:

It is estimated that the complete program will result in a reduction of 18 tons of PM.

Washington D.C. Mass Transit PM Retrofit

Planned Spending: \$1.95 million

Project Description:

Cummins Inc. intends to retrofit approximately 300 Washington Metropolitan Area Transit Authority (WMATA) buses powered by Cummins heavy-duty (HD) engines with emission control devices (ECD) as part of Cummins Inc.'s strategy to reduce PM, HC from heavy-duty engines. These advanced ECDs may include, but not be limited to diesel particulate filters (DPF), potentially from a variety of manufacturers. If successful during the two-year tracking period, these units will remain in service after conclusion of the project.

Project Goals:

The goals of this project are to:

1. Reduce PM and HC emissions from in-use heavy-duty diesel engines in local urban, ozone and PM non-attainment area neighborhoods;
2. Facilitate the successful retrofit of transit buses as well as their long-term maintenance;
3. Assess the effectiveness of DPF technologies in reducing pollution over long periods of time; and
4. Quantify the emissions reductions achieved from the retrofit program and from each emission control device;

Environmental Benefit:

It is estimated that the complete program will result in a reduction of 25 tons of PM.

Metropolitan Atlanta Rapid Transit Authority (MARTA) CNG Buses**Planned Spending: \$1.9 million****Project Description:**

Cummins Inc. intends to fund the difference in cost to the Metropolitan Atlanta Rapid Transit Authority (MARTA) between a Cummins diesel fuel engine MARTA would select for use in new urban buses and the corresponding Cummins Compressed Natural Gas (CNG) fueled engine.

MARTA is in the process of expanding their compressed natural gas (CNG) clean bus program. A significant impediment to this expansion is the high cost premium of heavy-duty (HD) CNG powered bus engines as compared to conventional diesel engines.

Cummins will provide the specified discount pricing for all the Cummins CNG engines acquired under this program up to the extent of committed funding, as noted above

Cummins proposed funding would provide discounts that are estimated to be sufficient for approximately 270 buses.

Project Goals:

1. Allow MARTA to procure additional clean CNG buses earlier than otherwise possible;
2. Improve regional air quality, enhance utilization of CNG refueling facilities and accelerate the development of sustainable refueling infrastructure; and
3. Provide high visibility and awareness of program to public via clear designation of CNG buses.

Environmental Benefit:

It is estimated that the complete program will result in a reduction of 1100 tons of NOx.

Massachusetts Bay Transit Authority (MBTA) CNG Buses

Planned Spending: \$1.9 million

Project Description:

Cummins Inc. intends to fund the difference in cost to the Massachusetts Bay Transit Authority (MBTA) between a Cummins diesel fuel engine MBTA would select for use in new urban buses and the corresponding Cummins Compressed Natural Gas (CNG) fueled engine. Cummins proposed funding would provide discounts that are estimated to be sufficient for approximately 270 buses.

Project Goals:

4. Allow MBTA to procure additional clean CNG buses earlier than otherwise possible;
5. Improve regional air quality, enhance utilization of CNG refueling facilities and accelerate the development of sustainable refueling infrastructure; and
6. Provide high visibility and awareness of program to public via clear designation of CNG buses.

Environmental Benefit:

It is estimated that the complete program will result in a reduction of 1100 tons of NOx.

Northeastern States Hybrid Bus Consortium

Planned Spending: \$1.97 million

Project Description:

Cummins New York City area distributor, Cummins Metropower Inc., has agreed to assist in the development of a consortium of Northeast properties for the purpose of developing a common purchase specification for hybrid buses optimized for their local duty cycles. The intent is to facilitate some purchasing leverage by consolidation of the purchase specifications. Cummins Inc. also will fund the premium cost between a conventional transit bus and the hybrid, to the extent of obligated funding. It is expected this funding would be sufficient for five hybrid buses.

Project Goals:

1. Define specification parameters for diesel-electric hybrid bus;
2. Integrate consortium members' specification requirements, perform value analysis review with help of technical advisors and produce one common specification for consortium's use;

3. Issue prototype bids to bus manufacturers, select and schedule prototypes for delivery to consortium members;
4. Assist prototype manufacturer with technical reviews during prototype building phase;
5. Work with authorities during in-service prototype testing phase;
6. Review final bids and select successful bidder(s);

Environmental Benefit:

It is estimated that the complete program will result in a reduction of 878 tons of NOx and 28 tons of PM.

Exhaust Aftertreatment Research and Demonstration Programs

Planned Spending: \$8.8 million

Project Description:

Cummins intends to develop and demonstrate the capability of advanced diesel engine aftertreatment technologies required to meet future NOx and particulate (PM) emissions requirements. This will include definition of the individual NOx or PM system requirements as well as the combined NOx/PM system.

Project Goals:

1. Develop a particulate aftertreatment sub-system, and related control systems, sensors and service procedures to maximize the useful life of the system and minimize impact on the customer;
2. Develop a NOx aftertreatment sub-system , and related control systems, sensors and service procedures to maximize the useful life of the system and minimize impact on the customer;
3. Integrate the combined system of particulate aftertreatment, NOx aftertreatment, sensors and control systems with the base engine; and
4. Provide recommendations of the production viability of the aftertreatment concepts.

Alternative Fuel Technology and Engine Program Hybrid Natural Gas Engine (B5.9 G-H) Development

Planned spending: \$2.4 million

Project Description:

In this project, Cummins intends to team with Allison Transmission and develop an optimum natural gas power plant and integrate with a hybrid drive train so as to maintain or significantly lower the emissions signature as well as enhance energy efficiency.

Project Goals:

1. Develop an electronic engine (drive by wire), robust controls, in-cylinder combustion optimizations; and
2. Integrate with an electric drive system.

Environmental Benefit:

Key emissions deliverables from this engine development include NO_x emissions at 1.5 g/bhp-hr; PM emissions at 0.02 g/bhp-hr; NMHC emissions at 0.6 g/bhp-hr; and CO emissions at 5.0 g/bhp-hr

Chassis Dynamometer Program

Planned spending: \$2.2 million

Project Description:

EPA, CARB and other emissions regulatory agencies have expressed interest in developing a broader understanding of in-use emissions from heavy-duty engines. This program will investigate the effect of engine use on emissions over time, and will begin to establish a database to correlate in-use, chassis-dynamometer-test, and engine-dynamometer-test emissions. The test program will establish baseline engine and vehicle emissions, track the engine through service, and test emissions periodically through the useful life period.

Project Goals:

The engine sampling and test program will begin when the vehicle facility is operational, currently targeted for June 2002. The proposed program will involve 24 on-highway engines in total from each of three successive model years from 2001 through 2003.

ARB Approved Projects

On-highway Low NOx Incentives (50 State Program)

Planned Spending: \$6.7 million (\$ 1.7 ARB, \$ 5.0 EPA)

Project Description:

Cummins intends to develop an incentive program to recalibrate engines to a lower emissions level. The program would be directed toward the owner-operator segment of the heavy-duty truck market utilizing engines built in 1996 and later. By targeting the most recently built engines, Cummins will maximize the emissions reduction potential (newer engines have fewer miles, and thus have the longest expected life before overhaul). The calibrations used for the program would use existing "Low NOx" calibrations currently submitted for the rebuild program.

Cummins intends to conduct reviews of this program annually to assure the programs effectiveness. Adjustments will be implemented as required.

Environmental Benefit:

It is estimated that the early recalibrations may result in 30,000 tons of NOx reductions.

Los Angeles Bus Repower

Planned Spending: \$1.2 million

Project Description:

Cummins Inc. intends to repower 30 school buses in the Los Angeles Unified School District with ISB engines and catalyzed particulate filters (DPF) at the rate of one bus per week commencing no later than 120 days after approval to proceed. These buses are configured for special education needs.

Environmental Benefit:

It is estimated that the complete program will result in a reduction of 85 tons of NOx and 46 tons of PM.

San Juan and Elk Grove Bus Repowers

Planned Spending: \$1.872 million

Project Description:

Cummins Inc. intends to repower school buses in San Juan and Elk Grove in Sacramento County with ISB engines and catalyzed particulate filters (DPF) at the rate of 7-8 buses per quarter for six quarters (total of 45 buses), commencing no later than 120 days after approval to proceed.

Environmental Benefit:

It is estimated that the complete program will result in a reduction of 128 tons of NOx and 68 tons of PM.

Alternative Fuel Technology and Engine Programs

The California Alternative Fuel Technology and Engine programs include:

- High Pressure Direct Injection (HPDI) LNG On-highway
- High Pressure Direct Injection (HPDI) Ultra Low Emissions Technology Development
- High Pressure Direct Injection (HPDI) Ultra Low Emissions Technology Development: Phase II - Field Testing
- ISL_G Natural Gas Engine Integration

High Pressure Direct Injection (HPDI) LNG On-highway

Planned Spending: \$300,000

Project Description:

Per the Memorandum of Understanding executed between Cummins and Westport Innovation to evaluate HPDI technology, Cummins intends to demonstrate high pressure direct injection (HPDI) of a natural gas in Cummins ISX engine for use in an on-highway truck. The key objectives are to maintain diesel-like power and engine efficiency similar to diesel but with lower NOx and PM emissions.

The project deliverables include 400 hp, 1,450 ft-lbs torque, 2 g NOx /bhp-hr and 0.02 PM g/bhp-hr .

The engine is to use an oxidation catalyst to reduce unburned hydrocarbons and CO.

The prototype engine/vehicle development has been on-going for the past year. It is planned to validate the engine performance, response, etc. by field test in two trucks in late 2000/2001 time frame. The prototype vehicle testing of one truck will likely be performed in the Sacramento area of California.

High Pressure Direct Injection (HPDI) Ultra Low Emissions Technology Development

Planned Spending: \$499,000

Project Description:

This program is a follow on to High Pressure Direct Injection LNG in On-highway Truck Program. In this program, the HPDI natural gas engine concept will be evaluated for lower NOx emissions. Exhaust Gas Recirculation (EGR)

technologies will be in production in 2002 in diesel platforms. This project intends to bring together cooled EGR technologies and HPDI concept on a Cummins model ISX engine.

The project deliverables include 400 hp, 1,450 ft-lbs torque, 0.5 g NOx /bhp-hr and 0.02 PM g/bhp-hr .

The engine concept is likely to require the use of oxidation catalyst to reduce unburned hydrocarbons and carbon monoxide.

This is a cost shared program. The funding consortium includes SCAQMD, DOE/NREL and CEC. The program has been approved for funding by SCAQMD board. The project team is made up of Cummins Inc. and Westport Innovations.

It is anticipated that this technology will be further evaluated in the field in a follow-up program. The prototype testing of the technology will likely be performed in Sacramento area.

High Pressure Direct Injection (HPDI) Ultra Low Emissions Technology Development: Phase II - Field Testing

Planned Spending: \$400,000

Project Description:

This program is a follow-up to the preceding High Pressure Direct Injection (HPDI) Ultra Low Emissions Technology Development program. The objective of this program is to field test the engine concept developed under the previous program.

The technologies developed under the High Pressure Direct Injection (HPDI) Ultra Low Emissions Technology Development program are ideally suited for the New Generation of Natural Gas Vehicle (NGNGV) class 8 vehicle project currently under discussion. The vehicle field test is planned for 2003 - 2004, with the objectives of demonstrating vehicle performance, reliability/ durability evaluations, discovering problems early and implementing design changes.

The project deliverables include 400 hp, 1,450 ft-lbs torque, 0.5 g NOx /bhp-hr and 0.02 PM g/bhp-hr .

An oxidation catalyst may be required to reduce unburned hydrocarbon and carbon monoxide in the exhaust.

The limited production engine system is most likely to be tested in California, replacing the HPDI natural gas engine (without EGR) planned for tests in 2001 -

2002. The overall project is contingent upon availability of external funds and teaming arrangements.

ISL_G Natural Gas Engine Integration

Planned Spending: \$600,000

Project Description:

Current production spark ignition (S.I.) engines exhibit approximately 0.2 g/bhp-hr NO_x. Spark ignition engines are less efficient (30-50 %) than the diesel engines in similar applications. This project intends to integrate lower emissions and high efficiency concepts on a new ISL platform. The results from this project will guide the product development of a natural gas ISL engine.

The project deliverables include 330 hp, 950 ft-lbs torque, 1.0 g NO_x /bhp-hr, 0.5 g/bhp-hr NMHC and 0.02 PM g/bhp-hr. The controls will have humidity & knock sensing capabilities.

The engine may require an oxidation catalyst to reduce unburned hydrocarbons and carbon monoxide.

Cummins cost share will cover the concept engine integration. Concurrently Cummins plans to seek external funds for product development and demonstration.

This technology integration work includes converting an ISL diesel engine into SI natural gas, turbomachinery matching and combustion design to enhance engine efficiency as well as lower emissions.

Advanced Emissions Measurement Support

Planned Spending: \$600,000

Project Description:

Cummins intends to provide funding of \$ 200,000 per year for three years beginning in 2001, to support the College of Engineering - Center for Environmental Research and Engineering (CE-CERT) development of a comprehensive new database of emissions in the South Coast area using the latest measuring technology which has been installed in the mobile emissions laboratory. The CE-CERT laboratory will be able to characterize the constituent elements in the South Coast area to a greater precision than previously possible, which should be of great benefit to equipment manufacturers and regulators alike.

A better understanding of the detailed chemistry that make-up the pollutants in the air should enable a more precisely targeted approach to eliminating or reducing those pollutants and in less time than would otherwise be the case.

These funds are supplementary to those provide from Federal, State or other private sources.